THE

ONTARIO WATER RESOURCES

COMMISSION

STUDY INTO THE FEASIBILITY

OF LOCATING

A WHEY DRYING PLANT

IN THE

STIRLING AREA

1970

A STUDY INTO THE FEASIBILITY OF LOCATING A WHEY DRYING PLANT IN THE STIRLING AREA

BY

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ONTARIO WATER RESOURCES COMMISSION

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A STUDY INTO THE FEASIBILITY OF LOCATING A WHEY DRYING PLANT IN THE STIRLING AREA

The disposal of liquid whey is a significant problem for most cheese factories in the Province of Ontario. This is especially true in the Central Ontario Region studied in this report where very little of the whey is used for animal feed or processed to make a saleable product.

All cheese factories in the area have made some effort to provide facilities to permit treatment of the waste whey. These usually consist of some manner of disposal on land. However, in most instances, the facilities provided to date are inadequate, as they do not treat the waste whey on a continuous and year round basis. Considerable further expenditures are required to upgrade the existing waste disposal facilities to provide satisfactory treatment on a continual basis.

The construction of a plant to recover the food values in whey may be a more suitable alternative to further expenditures on waste treatment. This study was therefore undertaken to investigate the economics of a large scale whey drying plant, built to service all the cheese factories in the area. as a possible solution of the whey disposal problem.

SUMMARY

The study was carried out to determine the feasibility of locating a whey drying plant with a capacity of 1,000,000 lbs. daily of raw whey in the Stirling Area. This plant would service thirty-one cheese factories

in the Counties of Northumberland, Hastings, Prince Edward, Lennox and Addington, Frontenac and Peterborough and produce a product suitable for human consumption.

Based on a selling price of 10¢ per lb. for the dried powder, it was found that a return on capital of 23.1% could be achieved. In the event that the plant should qualify for an Ontario Development Corporation forgivable loan of $500,000 for locating in a slow growth area, the return on capital would increase to 34.4% for the operators.

The calculations are based on the assumptions that a favourable market for spray dried whey powder will continue into the future and that a high quality product can be produced using the equipment described in the report.

It should be noted that this study was undertaken as a preliminary investigation into the economics of constructing a whey drying plant in the Stirling area and that more in depth investigations should be made before such a plant is built.

EXISTING WHEY DISPOSAL PROCEDURES

Thirty-one cheese factories are located in the area under study which includes the Counties of Northumberland, Hastings, Prince Edward, Lennox and Addington, Frontenac and Peterborough. The names of these cheese factories along with the existing methods of waste disposal are shown in Table I.

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TABLE I

CHEESE FACTORIES AND METHODS OF DISPOSAL*

NAME OF CHEESE FACTORY	COUNTY	METHOD OF DISPOSAL**
1. Beulah Co-op Butter and Cheese Limited	Hastings	Land Disposal
2. Central Cheese and Butter Company	Hastings	Spray Irrigation
3. Eldorado Cheese and Butter	Hastings	Land Disposal
4. Evergreen Cheese Factory	Hastings	Total Retention Lagoon
5. Foxboro Cheese Company	Hastings	All Wastes To Swamp
6. Harold Cheese Mfg. Company	Hastings	Wastes To Creek
7. Maple Dale Cheese Co-op	Hastings	All Wastes to Swamp
8. Plum Grove Cheese Co-op	Hastings	Total Retention Lagoon
9. Roblin Cheese Company	Hastings	Land Disposal
10. Shamrock Cheese Company	Hastings	Land Disposal
11. Trenton Riverside Dairy	Hastings	Municipal Sewers
12. Newburgh Milk Products Limited	Lennox and Addington	Land Disposal
13. Selby Cheese Factory	Lennox and Addington	Spray Irrigation
14. U. E. L. Cheese Factory	Lennox and Addington	Spray Irrigation
15. Wilton Dairy Company Limited	Lennox and Addington	Land Disposal
16. Anderson's Dairy Products Ltd.	Northumberland	Municipal Sewers
17. Crow Bay Cheese and Butter Company	Northumberland	Wastes To Swamp
18. Empire Cheese and Butter Co-op	Northumberland	Land Disposal

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TABLE I (CONTINUED)

NAME OF CHEESE FACTORY	COUNTY	METHOD OF DISPOSAL**
19. Hoards Cheese Company	Northumberland	Whey Hauled
20. Menie Cheese and Butter Co-op	Northumberland	Whey Hauled
21. Rylestone Cheese and Butter Co-op Limited	Northumberland	Whey Hauled
22. Swiss Cheese Factory	Northumberland	Whey Hauled
23. Warkworth Cheese Factory	Northumberland	Land Disposal
24. Ben Gill Cheese and Butter Co-op	Prince Edward	Land Disposal
25. Black River Cheese Company	Prince Edward	Seepage Pit
26. Elmbrook Cheese and Butter Company Limited	Prince Edward	Land Disposal
27. Mountain View Cheese Factory	Prince Edward	Wastes To Swamp
28. Quinte Milk Products Limited	Prince Edward	Whey Dried - Wash Waters Spray Irrigated
29. Pine Grove Cheese	Peterborough	Land Disposal
30. Harrowsmith Cheese Factory	Frontenac	Spray Irrigation
31. Battersea Cheese Factory	Frontenac	Wastes To Septic Tank

* Source - OWRC Industrial Waste Surveys

** It should be noted that although there are waste disposal facilities available at most of these plants, they very often do not provide complete treatment and are often inoperative for one reason or another.

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Liquid whey produced in the area under study amounts to about 200,000,000 lbs. annually. Only one plant in this area has facilities for processing whey into a saleable product. Its capacity, however, is limited to processing little more than its own peak production. Thus, it cannot service other plants in the area except at times of low whey production. It is estimated that of the total whey produced in the study area only about 10% is being processed into a saleable product or being fed to animals in the liquid form. This percentage is considerably below that for the Province as a whole (50%).

The remaining 180,000,000 lbs. per year of whey, having a BOD_5 loading of 6,300,000 lbs/year or equivalent to that from a city of 100,000 people, are disposed of in the cheapest manner permissible. This normally entails some form of land disposal.

The existing whey disposal facilities at most of the cheese factories in the study area are inadequate, however, since they do not provide satisfactory treatment on a continuous basis. It has been found that most of the factories have discharged whey to the natural watercourses at some time as a result of inoperable disposal facilities. Such discharges are in contravention of Section 27 (1) of The Ontario Water Resources Commission Act which reads as follows:

> "Every municipality or person that discharges or deposits or causes or permits the discharge or deposit of any material of any kind into or in any well, lake, river, pond, spring, stream, reservoir or other water or watercourse or on any shore or bank thereof or into or in any place that may impair the quality of the water of any well, lake,

river, pond, spring, stream, reservoir or other water or watercourse is guilty of an offence and on summary conviction is liable to a fine of not more than $1,000 or to imprisonment for a term of not more than one year, or to both."

The continued abuse of our natural waters cannot be tolerated. It is therefore imperative the corrective action be taken as quickly as possible. If such action is not taken, then the Commission will have no alternative but to take legal action under the terms of The Ontario Water Resources Commission Act.

Land disposal sites are susceptible to odour problems. As the Provincial air pollution regulations have been strengthened recently, cheese factories can expect greater restrictions to be placed on the odours from disposal sites in the future.

It is estimated that the cheese factories in the study area will have to spend in the order of $600,000 to install the additional disposal facilities required to treat the liquid wastes satisfactorily on a continuous and year round basis. Of this, approximately $500,000 can be attributed to the cost of treating the waste whey.

In summary, the whey disposal practices at most of the cheese factories in the study area are unsatisfactory and corrective action must be taken as quickly as possible.

SEASONAL FLUCTUATION OF WHEY SUPPLY

The rate at which whey is produced varies considerably from summer to winter. This seasonal variation is shown in Table II where the total

production of whey from the cheese factories in the study area is tabulated. As can be seen, the production in June is four times that produced in February. These large fluctuations in whey production lead to uneconomic conditions for operation of a spray drying plant during the winter months. Any leveling out of seasonal fluctuations would make the operation of a spray drying plant more economical.

For the purposes of this study, it was assumed that the whey drying plant would be sized to handle the peak production of whey and would operate throughout the year. During the winter it may only be necessary to operate the drying facilities two or three days per week.

At present, the Ontario Department of Agriculture and Food and the Ontario Milk Marketing Board are proposing changes in the supply of industrial milk in order to make the production of milk more attractive to the farmer in the winter, thus, producing milk fairly uniformly throughout the year. Far reaching changes are needed, including; paying higher prices for milk in winter, improving buildings, breeding control, better feeding, planning the freshening times of cows throughout the year, and improvements to the soil for growth of better forages and silages. Because of the large programme needed to bring about a more uniform milk supply, it is believed that movement in this direction will be very slow.

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TABLE II

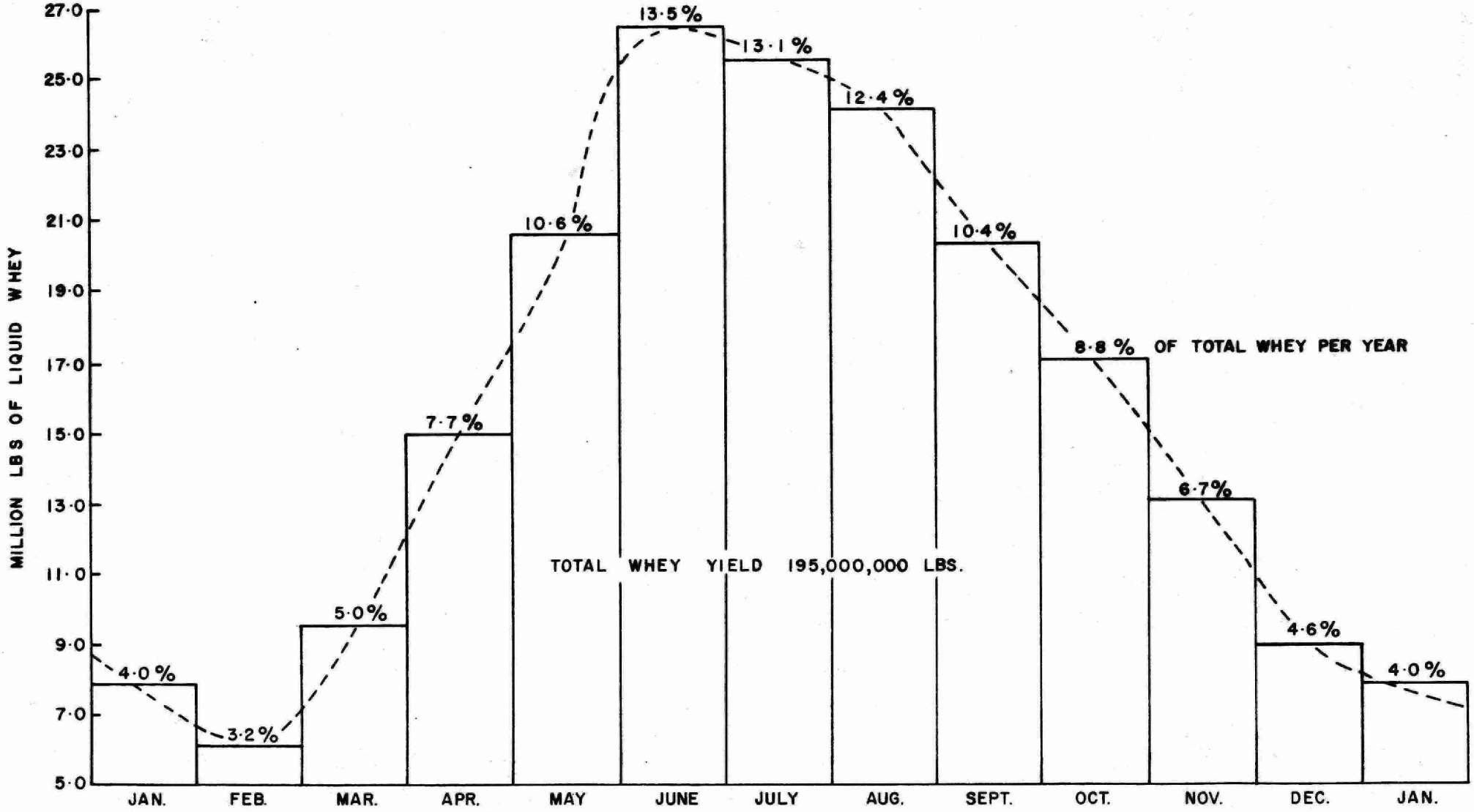
MONTHLY WHEY PRODUCTION FOR THE STUDY AREA*

MONTH	VOLUME (LBS.)	% OF YEARLY VOLUME
January	7,800,000	4.0
February	6,200,000	3.2
March	9,600,000	5.0
April	15,000,000	7.7
May	20,700,000	10.6
June	26,400,000	13.5
July	25,600,000	13.1
August	24,200,000	12.4
September	20,300,000	10.4
October	17,100,000	8.8
November	13,100,000	6.7
December	9,000,000	4.6
TOTALS	195,000,000	100.0

* Source - Report of the Ontario Cheese Industry Study Committee - November 1968

GRAPH I

THE VARIATION IN WHEY YIELD DURING THE YEAR



EQUIPMENT REQUIRED FOR WHEY DRYING

In order for a whey drying plant to be economically feasible, it must produce a high quality product suitable for human consumption. This would necessitate improved handling of the liquid whey at the cheese factories and in some cases it would require the installation of some new equipment.

Cheese Factories

All the raw milk must be delivered and held in stainless steel containers. In addition, all piping must be stainless steel. There must be provision made for pasteurization and cooling of the raw whey and sufficient storage in stainless steel containers (preferably insulated) for peak production. All the whey and milk lines would have to be cleaned daily. In summary, the precautions taken are similar to those needed for the production of fresh pasteurized milk.

Collection Facilities

A suitable number of bulk transport trucks would be necessary to service each of the cheese factories at least once per day. These trucks must be of the type used for the transport of bulk milk.

Whey Drying Plant

The whey drying plant must be sized to handle the whey production during the peak period. Storage for at least one day's delivery of liquid whey should be provided. All evaporators, storage tanks, pipe lines, etc. must be stainless steel and operated in a manner similar to that of a milk powder plant. Associated with the drying facilities there must be suitable warehousing provided to hold the dry powder for delivery.

The spray drying of whey has some problems which are not encountered with the spray drying of milk. However, the specialized equipment to overcome the problems has been included in the cost estimates for the proposed plant. Some of the problems encountered are; keeping the whey fresh, preventing the whey from clogging the plate evaporator, eliminating powder build-up on the walls of the spray-drier and production of a product which is 100% non-hygroscopic and will retain its produced form during long term storage.

CAPITAL COSTS OF WHEY DRYING PLANT

A breakdown of the Capital Costs for the construction of a whey drying plant based on 1969 market prices for equipment and buildings is shown in Table III. Also shown in Table III are the depreciation costs of the buildings and equipment used in calculating the fixed costs of operation of the plant.

FIXED COSTS OF OPERATING A WHEY DRYING PLANT

Listed in Table IV are the anticipated fixed costs for operating a whey drying plant for one year including; depreciation, wages, insurance, taxes, maintenance and repairs.

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TABLE III

CAPITAL COSTS

	Investment	Number of Years of Depreciation	Depreciation in Dollars Per Year
Buildings			
Plant, brick and tile construction 12,000 sq. ft. at $30. per sq. ft.	360,000	50	7,200
Warehouse, cement block construction 20,000 sq. ft. $12. per sq. ft.	240,000	40	6,000
Boiler Room	27,000	40	700
TOTAL	627,000		13,900
Equipment			
Evaporator 50,000 lbs. per hour including preheater	225,000	13	
Two stage dryer 4,300 lbs. per hour including high pressure pump, sifters, etc.	225,000	13	
Boiler, 17,000 lbs. steam per hour 500 H.P., Low pressure	25,000	13	
Refrigeration Unit	30,000	13	
Well or provision for cooling water supply	18,000	13	
Raw Storage (7 - 12,000 gallons)	85,000	13	
Concentrate storage, insulated and with a mixing device	45,000	13	
Cleaning-in-place	15,000	13	
Fork truck and pallets	18,000	13	
TOTAL	686,000		52,800
Transport			
Three diesel operated tractors	66,000	5	13,200
Three trailers	45,000	10	4,500
TOTAL	105,000		24,700
Wastewater Treatment			
Waste treatment plant	100,000	13	7,700
TOTAL GENERAL	1,518,000		92,000

TABLE IV

FIXED COSTS PER YEAR

Depreciation			
	Buildings	$	13,900
	Equipment		52,800
	Tractors and Trailers		17,700
	Wastewater Treatment		7,000
	TOTAL of Depreciation (Approximate)	$	92,100
Wages			
1	Manager	$	20,000
3	Operators (@ $8,000 per year)		24,000
2	Baggers (@ $6,250 per year)		12,500
1	Maintenance Man (@ $8,000 per year)		8,000
2	Clean-up Men (@ $6,250 per year)		12,500
4	Drivers (@ $8,000 per year)		32,000
1	Office		4,500
14	TOTAL WAGES	$	113,500
Miscellaneous			
	Fire Insurance Buildings - $6.85 per $1,000	$	4,300
	Contents - $4.03 per $1,000		1,100
	Boiler - $3.50 per $1,000		100
	Property Taxes $25.00 per $1,000		15,000
	Maintenance and repairs 1/2 of depreciation value (not including transport equipment)		37,000
	Clean-up Materials		7,500
	TOTAL of Miscellaneous Costs	$	65,000
	TOTAL of Fixed Costs		271,000

VARIABLE COSTS FOR OPERATING A WHEY DRYING PLANT

Variable costs were calculated on the following anticipated production data:

Total quantity of whey in lbs/year	200,000,000
Quantity of whey solids (6%) in lbs/year	12,000,000
Quantity of moisture in lbs/year	188,000,000
Quantity of whey powder with 5% moisture in lbs/year	12,600,000
Moisture removed by evaporation in lbs/year	175,000,000
Moisture removed by spray drying in lbs/year	12,400,000

These variable costs are listed in detail in Table V and are self-explanatory. However, the price of 0.7¢ per lb. of whey solids paid to the cheese factories requires some explanation. This has been included as an incentive to the cheese producer to provide good quality whey and to help defray any equipment costs the factories might encounter in providing the necessary facilities for the proper handling of whey. This payment would only be made when the whey provided is of good quality.

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TABLE V

VARIABLE COSTS PER YEAR

Production			
Steam	-	0.30 lbs. steam per lb. of water evaporated. Variable cost $0.80 per 1,000 lbs. of steam	$ 42,000
Natural Gas	-	3,000 BTU (920 BTU's per cu. ft.) to remove one lb. of water in a two stage dryer ($0.65 per 1,000 cu. ft.)	26,300
Water	-	0.04 gallons per lb. of water removed variable costs $0.20 per 1,000 gallons	1,500
Bags	-	$1.50 per 1,000 lbs. of powder	18,900
Electricity	-	$0.01 per cwt of whey processed	20,000
TOTAL of the Production Costs (Approximate)			$ 110,000
Raw Product			
Paid to Cheese Factories ($0.07 per lb. of whey solids)			$ 84,000
Transportation			
Based on a fuel consumption of 8 miles per gallon and a fuel cost of $0.36 per Imp. gallon, the operating cost per mile, including tires, tubes, recaps, repairs, grease and oil, is estimated at $0.12 per mile			48,000
Wastewater Treatment			
Based on a loss of 2% of the whey receipt, the BOD_5 loading will be 140,000 lbs. of BOD_5 per year. For aeration, 2 kwh per lb. of BOD_5 is needed at a price of $0.02 per kwh			5,600
TOTAL Variable Costs (Approximate)			$ 249,000

RETURN ON CAPITAL

Calculation of the return on Capital was made based on the foregoing cost estimates. This is shown in detail in Table VI. The return varies with the market price of whey powder and this relationship is shown in Graph II. Also as shown graphically and in the calculations, the assistance of a forgivable loan from the Ontario Development Corporation greatly improves the economic outlook for the location of a whey drying plant.

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GRAPH II

RETURN ON CAPITAL

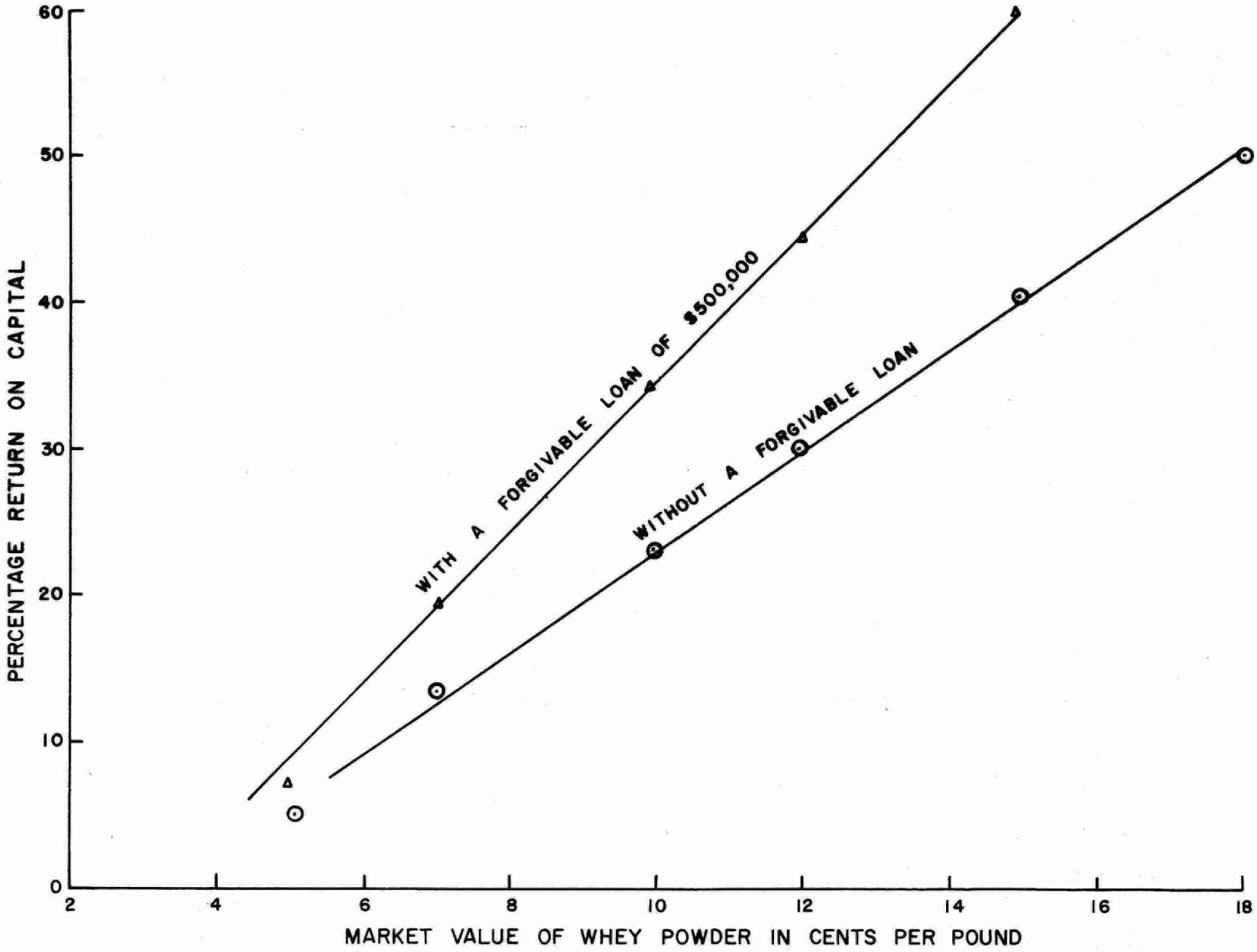

TABLE VI

RETURN ON CAPITAL

Production Costs	
Fixed	$ 271,000
Variable	249,000
TOTAL of Production Costs	$ 520,000
Sales	
15% of the whey powder is coloured and has to be sold as animal feed for 7¢ per lb.	$ 130,000
85% of the whey powder can be sold as first grade whey powder for human consumption at a minimum price of 10¢ per lb.	1,070,000
TOTAL of Sales	$ 1,200,000
Income Tax Calculation	
Total of Sales	$ 1,200,000
Production Costs	520,000
Gross Earnings	$ 680,000
Deduct interest charges (assuming 1/2 of capital is borrowed at 11% of mid-life value)	40,000
Taxable Earnings	$ 640,000
Income Taxes (52% of taxable earnings)	330,000
Return on Capital Calculation	
Total of Sales	$ 1,200,000
Production Costs	520,000
Gross Earnings	$ 680,000
Taxes	330,000
Earnings after Taxes	$ 350,000
Return on Capital ($1,518,000)	23.1%
Return on Capital ($1,018,000) (with Maximum Forgivable Loan of $500,000)	34.4%

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THE MARKETING OF WHEY POWDER

Spray dried whey powder suitable for human consumption has only been on the market for 6 - 8 years. For this reason, the pricing of this product has not been steady although there are some factors which are, at present, stabilizing the price. However, it should be noted that the future price of this product cannot be foretold accurately.

At this time, there is a good demand for good quality spray dried whey powder. However, the present shortage will soon be met with an estimated 200% increase in production capacity soon after January 1, 1970. At the present time, there is only one producer, located in Quebec, of a quality non-hygroscopic powder. A number of other products which are not 100% non-hygroscopic are marketed at a lower price. These "alternate" wheys currently sell at about 10-12¢ per lb. The quality product called "Krafen" sells at 12-1/2 - 15¢ per lb. It should be noted that the nutritional values of both products are equal and that they are also generally equally fit for human consumption. Of the powder to be introduced after January 1, 1970, at least 50% is anticipated to be of the high quality type.

At present, the market price of spray dried skim milk is controlled by the government at 21¢ per lb. In the manufacture of various products, it is possible to subsitute whey powder for skim milk powder in the ratio of about 3 to 2. Thus, the price of whey powder becomes attractive when it is in the order of 1/2 to 2/3 the price of skim milk powder. As the price of skim milk powder is expected to be controlled in the future at 21¢, the price of whey powder will not be expected to drop providing that there is not an overabundance of the product.

The addition of whey powder to many products is desirable for taste properties as well as appearance. However, the addition of whey powder to these products is limited due to a combination of problems. Whey powder is approximately 75% lactose by weight. At this time, the lactose content of many foods is limited by the Federal Government to 3%. Therefore, only about 4% whey powder can be added to any one of these products. Another problem is the physical nature of whey powder when added to some products. When the percentage of lactose in some substances becomes greater than 2 - 3% the lactose tends to crystallize out giving a "sandy" character to the product. Even if the 3% maximum on lactose content were increased there are some inherent problems in the use of lactose still to be overcome. Despite these problems, the market for whey powder is increasing and is expected to become even more important in the future.

In summary, it can be said that the future market for spray dried whey powder suitable for human consumption is good. However, in the short term it appears that there will be an excess of supply over demand due to the completion of two new spray drying plants. One of these plants will be in Quebec, the other at Ingleside, Ontario. The construction of a further plant would be expected to have some effect on the market price for spray dried whey powder.

OTHER PRODUCTS

A possible solution to overcoming a soft market in spray dried whey powder is diversification into whey by-products.

Due to the fact that a high lactose content is unfavourable, it is of advantage to produce a delactosed whey powder. This would be done by condensing the whey to about 60% solids, crystallizing the excess lactose and decanting the liquid. Somewhat more than 50% of the lactose could be removed in this way making the finished product more attractive. The lactose could also be recovered and marketed.

Other products, such as the lactalbumin and lactoglobblin can be recovered and sold more easily than spray dried whey. It may also be possible to produce the by-products from that whey which cannot be classed as top quality (e.g. coloured whey). This would then provide an alternate means of disposal of that whey powder which could only otherwise be sold as animal grade.

Also, it may be of benefit to construct a multi-purpose plant producing cheese, butter, spray dried milk and whey as well as by-products. In this way, it would be possible to produce specific products as the market demands thereby reducing warehousing of large amounts of material. Such a diversified plant may be able to attract capital more easily than one constructed specifically for the drying of whey.

Production of any of the above products would require further processing equipment. The economics of diversifying was not considered in this survey.

CENTRALIZATION OF CHEESE MAKING FACILITIES

Centralizing the cheese factories into one large unit or into three or four smaller units is an attractive way of overcoming the problem of

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quality control of the raw whey. In this way, a more uniform raw product can be obtained, less transportation would be required and possibly fewer delays in transferring the whey from the cheese factory to the drying plant would be encountered. A further consideration is, of course, that the larger cheese factory is generally a more economic unit to operate.

One large cheese factory located adjacent to a whey drying plant is the most economic unit that can be considered. In such a plant there would not be the need for duplication of equipment for handling the liquid whey as in the case of a number of small factories. There would not be any transportation charges for whey, although those for the raw milk may become somewhat higher. An integrated unit would also do away with the need of stainless steel holding tanks at both the cheese factory and the whey drying plant.

However, the most important argument for location of a large cheese plant beside the whey drying plant is that of quality control. The importance of quality in the marketing of whey powder is such that the construction of a plant is dependent on it. A plant not producing predominantly 100% non-hygroscopic whey powder suitable for human consumption is not believed to be economic.

CONCLUSIONS

This study has pointed out that whey drying can be a profitable diversification of the dairy industry, and not the money-losing project that it has commonly been considered to be. The reason for the pessimistic view is that most previous attempts at whey drying were geared

simply to producing an animal grade food product on a small scale with inefficient equipment. The use of large scale, modern, efficient equipment to produce a high quality whey powder suitable for human consumption indeed would appear to be a profitable way of solving a serious waste disposal problem.

The location of such a modern installation in a slow growth area as designated by the Ontario Development Corporation should make it qualify for a forgivable loan under the Equalization of Industrial Opportunity Programme. If the maximum of $500,000 could be obtained under this scheme, the return on investment for the operators of such a plant would increase from 23.1% to 34.4% assuming a market price for dried whey of 10¢ per lb.

The location of a whey drying plant, however, must be dependent on two factors; the market for dried whey powder and the quality of the product produced. It would be of benefit to have a buyer for a substantial portion of the product before a plant is built. This would ensure a market for the whey should there be overproduction for a period of time. Also a plant intending to service a large number of cheese factories must be prepared to offer some incentive to the cheese factory to produce good quality whey. Sour, coloured or dirty whey make it unsuitable for use in foods intended for human consumption.

In summary, the location of a whey drying plant in the Stirling Area is feasible providing the following conditions are met:

(1) It is a modern large scale plant producing a high quality 100% non-hygroscopic whey powder suitable for human consumption.

(2) It qualifies for a forgivable loan from the Ontario Development Corporation.

(3) It can be assured of a high quality supply of raw whey from the cheese factories in the area.

(4) Market conditions for the intended product remain as they are at present.

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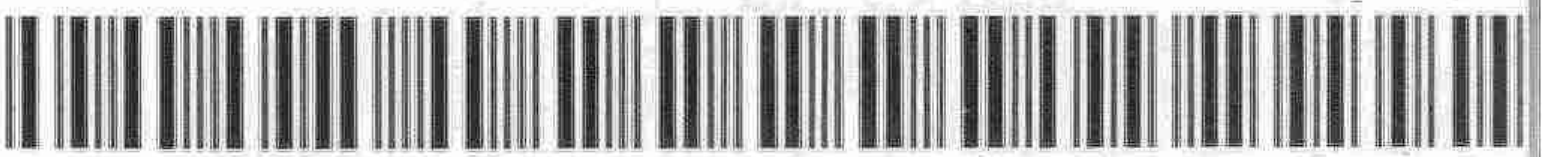
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